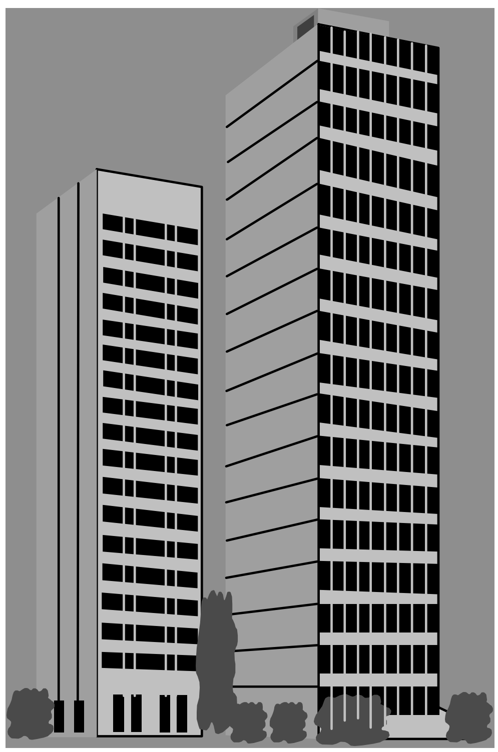
INDOOR AIR QUALITY ASSESSMENT

Berkshire Family & Probate Court
44 Bankers Row
Pittsfield, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Francis Maranaro, Clerk of Courts for the Norfolk Family Court, the Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality issues and health concerns at the Berkshire Family & Probate Court located in Pittsfield, MA**.**

On June 24, 1999, Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), made a visit to this building. The Berkshire Family & Probate Court (BFPC) is a two-story stone block structure built in 1874. The BFPC is comprised of four distinct sections: west, east central and south (see Picture 1). The second floor of the east and west sections contain large stained-glass windows in the north and south walls which are topped by steep peaked roofs covered with slate shingles. The central section connects the east and west section. It contains a large skylight surrounded by a steep peaked roof (see Picture 2). The south section has two roofs (see Picture 3) and is connected to the rear of the central section. A steep, peaked slate shingled roof covers the second floor of the south section while the first floor offices not directly beneath the second floor are covered by a low-slope, rubber membrane roof (see Picture 4).

In 1978, major renovations were made to convert this building from a library into a court building. In order to stabilize the east, west and central sections, a crisscrossing latticework of tiebacks were installed in the exterior walls of the first and second floors. A tieback is a steel bar that is affixed to opposing exterior walls to arrest wall movement (see Picture 5). Since tiebacks could not be installed in the existing stained-glass windows the exterior walls of the second floor of the central, east and west sections are wrapped with connected horizontal steel bars (see Picture 6). The south section was originally a large two-story room. A second floor was constructed in this area, which is currently the Deed Room. A modern air ducted ventilation system was also added to the building. The air-handling unit is located in the basement.

The second floor of this building contains the registry of deeds, the registrar's office and a satellite office of the Mass Co-op Extension. The first floor consists of Court 1, Court 2, judge's chambers, clerk's office, probation office and the main entrance. The basement consists of jury meeting rooms, file storage and the mechanical room.

Methods

Air measurements for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor. Temperature and relative humidity measurements were taken with the Mannix, ThPen PTH8708 Hygrometer/Thermometer.

Results

The courthouse has a population of approximately 35 employees and an estimated 150-700 other individuals who visit the court on a daily basis. Measurements were collected under normal operating conditions. Test results appear in Tables 1-4, according to their sample location.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were above 800 parts per million parts of air [ppm] in seventeen out of twenty-eight areas sampled throughout the BFPC. These carbon dioxide levels are indicative of an inadequate fresh air supply in a number of areas within the BFPC. Of note were the grand jury room, basement storeroom, basement file room, probation-private office (SW), client conference room, presiding judge's chambers and the rear office of the assistant registrar, which were all above 800 ppm without occupancy indicating little or no air exchange.

An air-handling unit (AHU) located in the basement beneath the south wall of the south section of the building supplies fresh air. The fresh air intake is located at the base of the south wall, in a cement-lined pit. Fresh air is drawn into the AHU and distributed by ducts to diffusers that are installed flush in the floor of first floor offices and through wall mounted air diffusers in other areas. The fresh air intakes for the AHU were found closed. This results in little fresh air introduction into the ventilation system. Internal return air is therefore re-circulated throughout the building. The finding of carbon dioxide levels above the MDPH recommended comfort guidelines in the unoccupied areas of the basement grand jury rooms and storage areas further indicated that the AHU is re-circulating air from occupied office areas without mixing adequate amounts of fresh air. Fresh air dampers need to be open in order to draw fresh air into the system.

Fresh air supply diffusers located in floors were found routinely blocked with file cabinets, carpeting and other items. In order to function as designed, air diffusers must be unblocked and remain free of obstructions. The probation-private office SW and the probate file room contained two air diffusers. In both these areas, it appears that only one of the two air diffusers was functioning. The basement file room, main lobby, and dark room do not contain mechanical supply ventilation. Renovations that created the office area for the 2nd judge's secretary's office appear to separate this area from the existing ventilation system.

In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last servicing and balancing of these systems was not available at the time of the visit.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself at levels measured in this building. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Reports of temperature discomfort were made to BEHA staff. The BEHA recommends that indoor air temperatures be maintained in a range between 70° F to 78° F in order to provide for the comfort of building occupants. Temperature readings were between 71 ° F to 75 ° F in occupied areas, which is within the BEHA recommended range for comfort. Areas in the basement that were not occupied during this assessment had temperature readings of 66 ° F to 67 ° F, which is below the recommended comfort range. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity measured within this building was found within a range of 43-65 percent throughout the building. This range of relative humidity was close to the BEHA comfort range of 40-60 percent. However, indoor relative humidity outside the heating season would be expected to be near or below the relative humidity outdoors. These relative humidity levels were significantly above the outdoor background level sampled during this inspection (> 20 percent). This can be another indicator of poor air exchange. Without properly functioning fresh air supply and exhaust ventilation, water vapor produced by building occupants and other sources will build up since it is not being diluted or removed from the building by the ventilation system. Relative humidity levels in the basement storage area and the grand jury room basement (SW) had relative humidity levels of 65 percent. With increased outdoor humidity, this relative humidity level may readily increase to over 70 percent. Relative humidity measurements over 70 percent can provide optimum conditions to grow mold within a building (ASHRAE, 1989). Materials that may be susceptible to mold colonization in this area are cardboard, paper and book bindings. These relative humidity levels should drop during the heating season. Relative humidity is more difficult to control during the winter heating season. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. The sensation of dryness and irritation is common in a low relative humidity environment.

Microbial/Moisture Concerns

As noted in the background section, alterations to stabilize the exterior walls of the east, west and center sections were made with the installation of tiebacks inside and the steel support band on the exterior of the building. As part of these renovations, plexiglass was installed over the interior window frames of the stained-glass windows of the north and south walls of the east and west section. Plexiglass sheets were cut to fit over the window frames and were attached to the walls with screws (see Pictures 7 & 8). The exterior sides of the stained-glass windows are exposed to the outdoors without similar storm window protection. Broken pieces of the stained-glass window were observed, which can readily allow water to enter into the space created and its plexiglass covering. Seals in and around the stained-glass windows appear to be leaking; resulting in water damaged plaster. The warm, moist environment between windowpanes can provide conditions conducive to microbial growth.

The plaster in the south section, first floor also had water damage, which can indicate moisture penetration through window frames, doorframes or exterior wall mortar. Plaster can serve as a growth medium for mold.

Exterior walls and grounds around the perimeter of the south section may have potential problems with water accumulation and drainage. The south section has cement-lined pits along its east, west and south walls. Windows that provide light and ventilation to the grand jury and storerooms exist in the walls of these pits (see Picture 9). Each pit appears to have a drain, which is designed to remove water and prevent flooding as well as subsequent water penetration through these basement window frames. A significant amount of debris has accumulated within these pits, which appears to partially block these drains (see Picture 10). This may result in water penetration into basement window frames. A severely bowed windowsill was found in a window of a grand jury room, which may indicate water penetration. This debris should be cleaned from drains and the area should be inspected periodically for proper drainage to avoid standing water collecting outside of ground floor windows. Standing water can become stagnant and provide an additional medium for bacterial and microbial growth.

Enhancing water accumulation in this pit is the lack of a gutter system along the high peaked and low sloped roofs of the south section. It appears that the renovations resulted in the building's gutter system being sealed and abandoned (see Picture 11). Rainwater runs directly off the high peaked slate roof, which in turn runs directly off the low sloped roof into the pits flanking the south section. This low sloped roof also allows for the accumulation of snow that slides from the high peaked roof. Accumulation of snow can create ice dams, which can result in damage to the material of the low slope roof and enhance water penetration into the building's interior.

A number of potential sources of mold colonization exist within the building. Water damaged wall and ceiling plaster was noted in a number of areas in the building such as areas adjacent to the southwest portion of the south wall of the south section. Efflorescence (i.e. mineral deposits) was observed on exterior surfaces of brickwork above windows. Efflorescence is a characteristic sign of water movement through brickwork, as moisture penetrates and works its way through mortar around brick and leaves behind these characteristic mineral deposits. The efflorescence around window brick and water damage to interior window frame wood or plaster can be a sign of water penetration through brick or mortar. Water-damaged wall and ceiling plaster can provide a source of mold growth, especially if it becomes wet repeatedly. Water damaged building materials should be replaced after a water leak is discovered and repaired.

Caulking around the exterior of windowpanes of the second floor south section windows was observed crumbling, missing or damaged. Many areas had water damaged window frames and wall plaster, which is evidence of water intrusion through improperly sealed windows. Repeated water damage can result in mold colonization of wall plaster and wooden window frames.

Another potential source of mold and spores are the numerous plants located in the registrar's office and court 1. Plants were observed resting on paper towels located on wooden windowsills. Over-watered plants can saturate the paper towels allowing moisture to penetrate into wooden window frames. If wetted repeatedly, these wooden windowsills can become water damaged and provide a source of mold growth. Plants should be equipped with drip pans. Plant soil and drip pans can also be a source of mold growth and need to be cleaned and disinfected regularly.

A number of water damaged ceiling tiles were noted in the main office of the registry of deeds. A missing ceiling tile revealed that a layer of fiberglass insulation is installed on top of the suspended ceiling. This suspended ceiling is suspended directly below the skylight over the central section of the BCFC. Water damaged ceiling tiles can indicate water leaks through this window system. Both water-damaged ceiling tiles and fiberglass insulation can serve as media for mold growth.

The registrar of deeds office has a hole in the vaulted ceiling which reportedly leaks water during rainstorms (see Picture 12). Water leakage in the ceiling near an exterior wall can be an indication of damaged slate shingles or roof flashing. Water-damaged wall and ceiling plaster can provide a source of mold growth, especially if it becomes wet repeatedly. Water damaged building materials should be replaced after a water leak is discovered and repaired.

Other Concerns

The BFPC has a number of restrooms located throughout the building. Restrooms with exhaust vents had little air movement, indicating that either motors to these vents are not operational or that this is a gravity exhaust system, which operates on the principle of heated air rising though ductwork creating negative pressure to draw restroom odors. Due to the lack of vent ducts on the roofs, it is possible that exhaust vents for restrooms were either sealed or abandoned. A number of restrooms in the clerk's office have no mechanical ventilation. Ventilation in restrooms is necessary to prevent odors from migrating into adjacent hallways and offices.

Conclusions/Recommendations

The solution to indoor air quality problems noted is complicated. Observed conditions and air testing are consistent with what might be encountered in a building without proper drainage of rainwater and a poorly operating ventilation system. The conversion of this building from a library into a court complex provided a functioning mechanical ventilation system that can be adjusted to improve comfort in this building. The aging, leaking window frames, lack of a roof gutter system, poor drainage at the base of the building and roof as well as skylight leaks, combined with the absence of weather protection for the stained-glass windows, provide ready means for water to penetrate into the interior of this building.

Because of these conditions a two-phase approach is required, consisting of immediate measures to improve air quality and long term measures that will require planning and resources to adequately address the overall indoor air quality. The short-term recommendations can be implemented as soon as possible. In view of the findings at the time of this visit, the following recommendations are made:

Short-term Recommendations

1. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
2. Consider using a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to reduce the aerosolization of respirable dusts.
3. During times of increased humidity, consider operating a dehumidifier in storage areas in the basement to prevent mold growth in stored records. Please note that dehumidifiers can be a source of microbial growth if not properly operated and maintained. Follow the dehumidifier manufacturer's operation and maintenance recommendations.

4. Consider contacting a ventilation engineer to evaluate the function of the AHU. Ensure that the fresh air damper is open and functioning in order to provide a supply of fresh air. Examine the exhaust vent for the AHU to determine if open and providing exhaust ventilation.
5. Evaluate general exhaust system for function and repair. Examine restroom exhaust ventilation for proper function. Replace/repair parts and motors as needed. Operate restroom local exhaust ventilation during work hours.
6. Remove materials blocking floor air diffusers in offices.
7. Once both the fresh air supply and the exhaust ventilation are functioning properly, the ventilation system should be balanced.
8. Clean concrete lined pits around the south section. Ensure that the drains in the floor of these pits are clean and providing an adequate amount of drainage to prevent pooling water.
9. Repair active roof/plumbing leaks and replace any remaining water damaged ceiling tiles. Examine the area above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial. This measure will remove any actively growing mold colonies that may be present. Ceiling tiles should be removed at a time when employees are not present in the workplace. Contain the area where ceiling tiles are removed to prevent the spread of dust and mold spores in the workplace. This practice should be conducted routinely.
10. Repair water damaged ceilings, walls and wall-plaster. Examine the water-damaged area for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

11. In order to prevent the development of ice dams on the low slope roof, snow should be removed from these roofs as soon a practicable after snowstorms. Please note that the method to remove snow should not damage the roof material.
12. Ensure plants are equipped with drip pans. Move excessive numbers of plants from windows. Discontinue the use of paper towels on wooden windowsills to absorb excess water underneath plants. Inspect drip pans periodically, clean and disinfect with an appropriate antimicrobial as necessary.

The key issue is to limit the amount of water penetration into the building through the roof, and window systems. The following long-term solutions to address these water penetration issues should be considered.

Long-term Recommendations

1. Examine the feasibility of providing an exterior storm window or an equivalent treatment to the exterior of the stained-glass windows to prevent water penetration. Consider consulting a restoration consultant for the best method for repairing broken sections of the stained-glass windows.
2. Examine the feasibility of restoring the original gutter and downspout system to improve water drainage from the roof.
3. Consider consulting a building engineer to examine the exterior of walls on the southwest portion of the south wall of the south section to determine the means by which water is penetrating into the interior of the building.

4. Consider consulting a building engineer to examine the waterproof integrity of the central section skylight. Consideration should be given to repairing this structure to prevent water penetration.
5. Consider consulting a building engineer to examine the slate roof and flashing above the west sections to water leakage and recommendations for the best feasible method for repair.
6. Consider consulting a building engineer to examine the window systems for the first floor south section for first floor windows and recommendations for the best feasible method for repair.

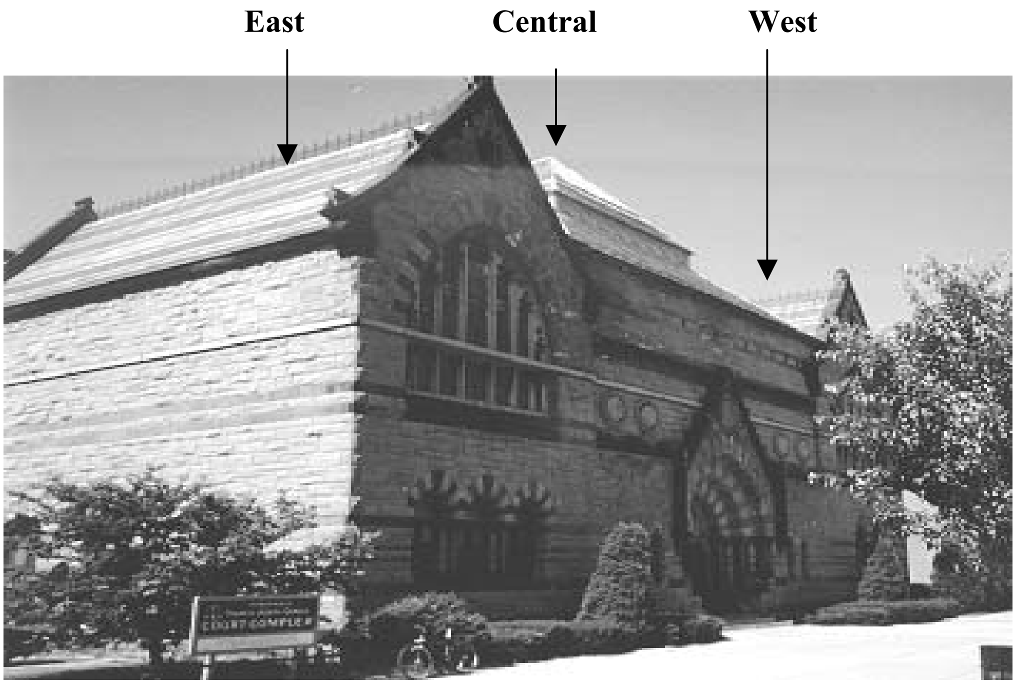
References

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Picture 1



East, Central and West Sections of the Courthouse

Picture 2 **Skylight above Registry of Deeds Main Office**

Picture 3

Low Slope Roof

Peaked, Slate Shingle Roof

Two Roofs of the South Section

Picture 4

Low Slope Roof of South Section
Note That Roof Renovations Sealed the Built-in Gutter System on the South Wing,
Allowing Rainwater and Snow to Drop into a Pit Located at the Base of the Exterior Wall

Picture 5

Tieback Fasteners

Stain Glass Windows without Exterior Storm Windows,
Note Tie Back Fasteners in the Walls

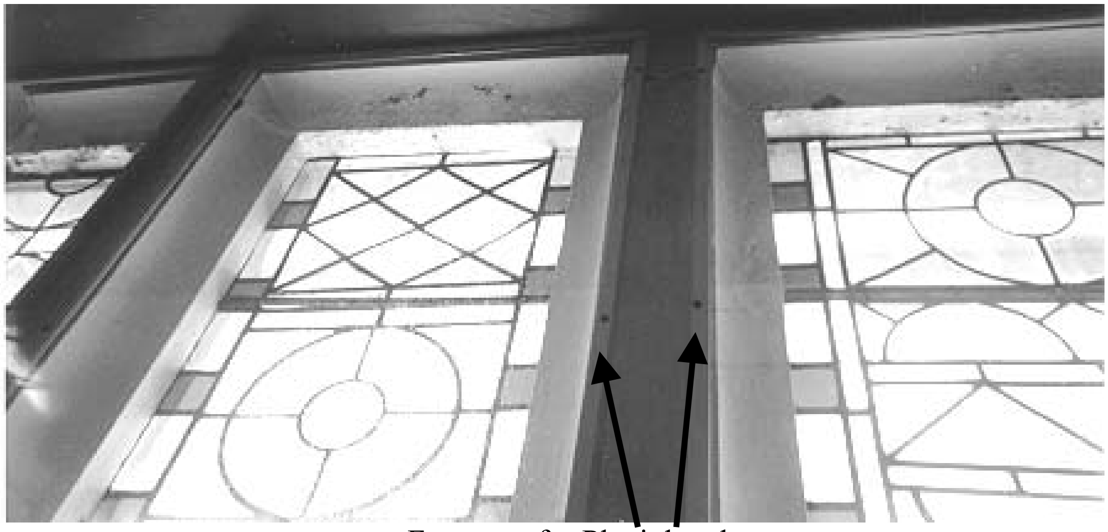
Picture 6

Horizontal Steel Bar

Tieback Fasteners

Stain Glass Windows without Exterior Storm Windows,
Note Tie Back Fasteners in Walls and as Well as Exterior Steel Beam

Picture 7



Fasteners for Plexiglas sheets

Water Damaged Stain Glass Window Frames,
Note the Installation of Plexiglas over the Interior of the Window Frame(s)

Picture 8

Fasteners for Plexiglas sheets

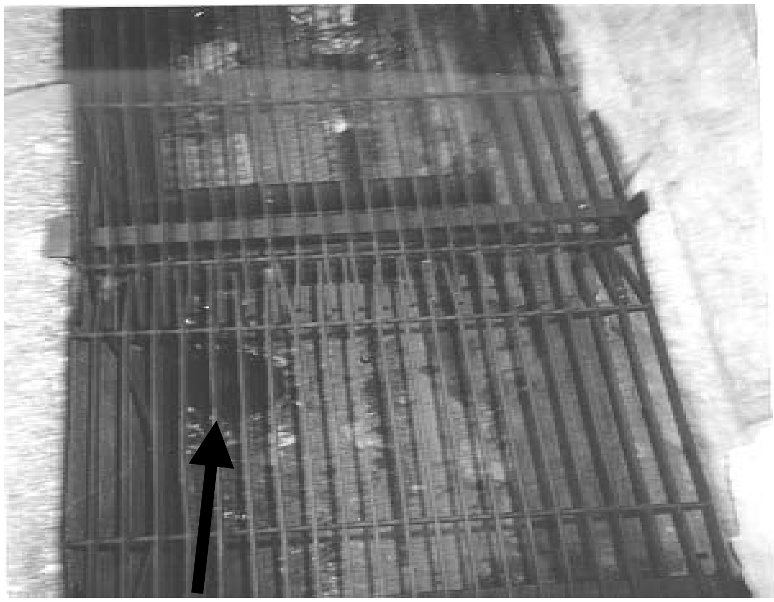
Water Damaged Stain Glass Window Frames,
Note the Installation of Plexiglas over the Interior of the Window Frame(s)

Picture 9

Window Grate

Pit at the Base of the South Wing
Note Grate That Covers Window to Room in Basement
Note the Collection of Sand and Debris in Floor of Pit

Picture 10



Drain

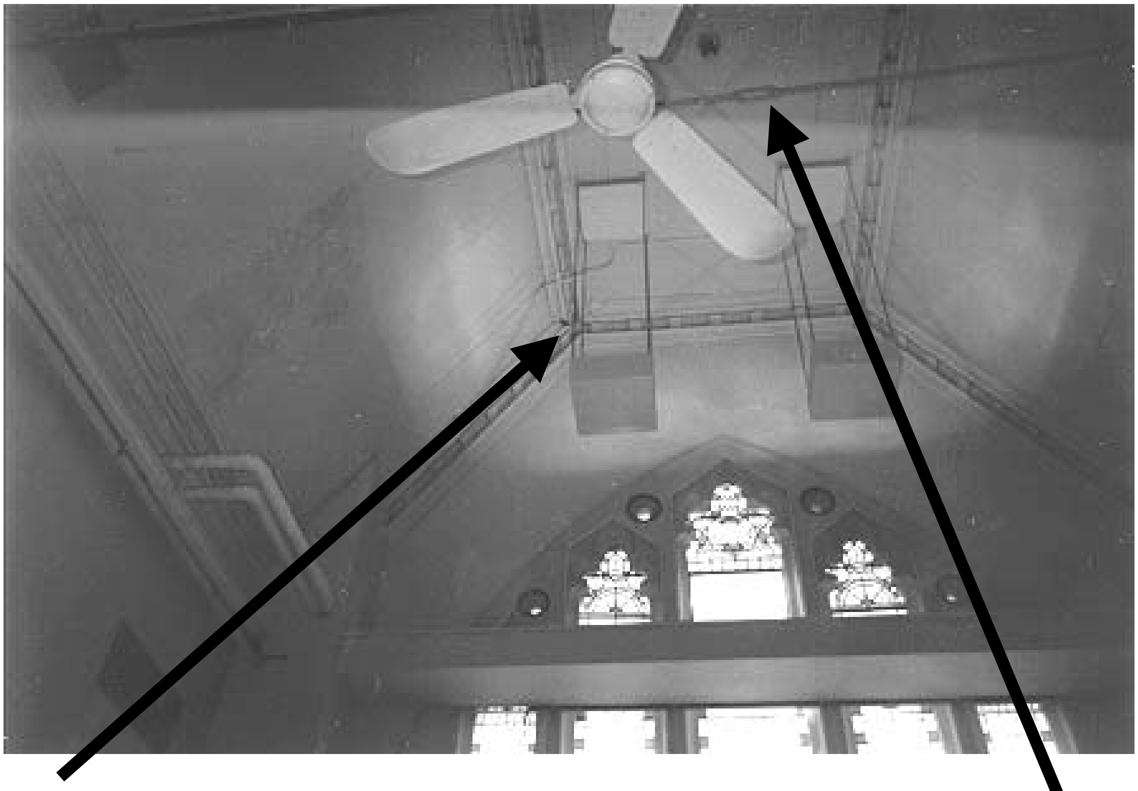
Pit at the Base of the South Wing

Note Debris Clogging Drain

Picture 11

Roof of the South Wing of the Court House, Gutter Downspout Opening

Picture 12



Hole in Ceiling | Tie Back Bar

Interior View of Vaulted Ceiling in West Wing
Note Hole in Plaster with Water Damage and Tie-Back Bar

TABLE 1

Indoor Air Test Results – Berkshire Family & Probate Court, Pittsfield – June 24, 1999

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Openable Windows	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	373	87	20					wind-25 mph, SW
Registrar's Office	949	78	43	3	yes	yes	yes	
Grand Jury Room Basement NW	830	67	54	0	yes	yes	yes	unoccupied
Grand Jury Room Basement SW	866	66	63	0	yes	yes	yes	CT(2)
Basement Storeroom	863	66	65	0	no	yes	yes	CT(1)
Basement File Room	879	71	56	0	yes	no	no	CT(9)
Courtroom 1	946	73	57	14	no	yes	yes	plants on paper-over air diffusers
Courtroom 2	965	72	55	11	yes	yes	yes	water-damaged plaster, bowed ceiling
Main Lobby	964	73	51	8	no	no	no	elevator
Probation – Private Office, NW	927	72	48	1	yes	yes	yes	exhaust off, portable fan, door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Berkshire Family & Probate Court, Pittsfield – June 24, 1999

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Openable Windows	Ventilation		Remarks
						Intake	Exhaust	
Probation – Private Office, SW	881	70	56	0	yes	yes (2)	yes	1 of 2 air supplies functioning, exhaust off, water-damaged wall & ceiling plaster, door open
Client Conference Room	821	74	49	0	no	yes	no	ceiling tiles ajar
Clerk of Probate-Main Office	861	74	44	5	yes	yes	yes	
Judge's Chambers – Presiding Judge	858	73	45	0	yes	yes (2)	yes	1 of 2 air supplies functioning-blocked by carpet
Probate File Room	836	73	45	1	yes	yes (2)	yes	both air supplies functioning-blocked by file cabinets
Rear Office Assist. Registrar	828	72	48	0	yes	yes	yes	door open
Court 1	791	72	48	0	no	yes	yes	
2nd Judge Secretary's Office	762	71	45	1	no	no	yes	
2nd Judge's Chambers	782	71	48	1	yes	yes	yes	louvers shut-both supply and exhaust, door open
Chief Probation Officer		71	52	1	yes	yes	no	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Berkshire Family & Probate Court, Pittsfield – June 24, 1999

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Openable Windows	Ventilation		Remarks
						Intake	Exhaust	
Probation Office	932	72	52	2	yes	yes (2)	yes	door open, supply partially blocked
Front Lobby	869	70	52	1	no	yes	yes	
Dark Room	761	72	49	0	no	no	no	no chemicals, door open
Registry of Deeds – Main Office	742	71	47	5	no	yes	yes	CT(10+), missing ceiling tiles-exposed fiberglass, door open
Registrar's Office	721	75	42	2	no	yes	yes	missing panes stained glass- cracks in window frame
Deed Room NW	679	74	40	4	yes	yes	yes	water-damaged plaster
Deed Room SW	662	71	43	2	yes	yes	yes	cracks – windows
Deed Room SE	659	71	44	3	yes	yes	yes	
Deed Room NE	670	72	46	3	yes	yes	yes	
Outer Hallway – Deeds	681	71	47	2	no	yes	yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Berkshire Family & Probate Court, Pittsfield – June 24, 1999

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Openable Windows	Ventilation		Remarks
						Intake	Exhaust	
Mass. Co-op Extension	680	73	45	1	no	yes	yes	ceiling fans, door open, stained glass, water-damaged window frames/wall plaster/ ceiling plaster

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%